Florida GIS

Baseline Specifications for Orthophotography and LiDAR

V 1.2

Revision History

Version	Date	Description
0.9	10/17/06	Draft released
0.9.1	04/04/07	LiDAR sensor specification field of view changed to 40^0 (20^0 off nadir) Changed “historical images” to “existing orthophotography”
0.9.2	05/10/07	Orthophoto horizontal accuracy changed to 7.6 feet. Flight season revised.
1.0	06/01/07	Draft status removed
1.1	10/25/2007	Breakline clarifications made, list of Florida counties by state plane zone added, and additional contour domains added for contours in low confidence areas.
1.2	12/12/2007	Added x, y, z, fields for control points, added domain for land cover type, changed project identifier to be stored in GUID data 4 instead of 1.

Table of Contents

Introduction

A coalition of GIS practitioners, including the Florida Division of Emergency Management, Florida Water Management Districts, Florida Fish and Wildlife Conservation Commission, Florida Department of Environmental Protection, Army Corp of Engineers Jacksonville District, and other state and federal agencies, have come together to develop baseline specifications for orthophotography and LiDAR data collection for publicly funded projects within Florida.

Interest in acquiring orthophotography and LiDAR has risen significantly as beneficiaries of the data learn about the many uses of remote-sensing technologies. These uses range from floodplain mapping to homeland security planning. As interest in remote sensing technologies has grown so has the understanding of the need to coordinate data collection. Growth management, map modernization/floodplain mapping, natural lands stewardship, and disaster preparedness are statewide issues with statewide impacts.

A number of projects managed through state agencies, Water Management Districts, and federal and local governments have been used for conducting hydrological studies, monitoring coastline changes, creating highly accurate elevation data, managing growth, and more. Beneficiaries of statewide datasets include local county and city governments, a majority of state agencies (especially those with growth management, land stewardship, and disaster management responsibilities), and federal partners. Coordination and establishing baseline specifications are paramount to the successful acquisition of a high-resolution statewide coverage that meets the needs of the broadest number of stakeholders. Such coordination will maximize funding and the availability of human resources and equipment for all beneficiaries of these data. Additionally, coordination will reduce the likelihood of duplicate projects and provide datasets for smaller agencies or local governments that would have significant difficulty funding projects but that might gain the most benefit from using such data.

These Specifications are intended to be an evolving document, growing and changing with technological advances and identified needs. The Florida Division of Emergency Management will initially be responsible for maintaining these specifications and making them available at http://floridadisaster.org/gis/specifications. Revisions to these specifications shall be by approval of the sponsoring agencies. Please check this website to make sure you are referencing the most current version.

Purpose of Specifications

These baseline specifications are intended to ensure that data acquired with public funding will provide a seamless statewide dataset for use by the broadest number of stakeholders. Implementation of the specifications will ensure that potential data users have sufficient information to assess the accuracy, precision, and suitability of data for their purposes. Enabling users to assess the quality of the data and implement these baseline specifications should help preserve the value of the data and foster data sharing. Data sharing should result in more efficient and less expensive data collection for the citizens of Florida.

Specification Overview

An overview of the specifications that constitute the baseline specifications is provided below. The complete definitions of these specifications are detailed in Appendix 1 for orthophotography, Appendix 2 for terrestrial LiDAR, and Appendix 3 for bathymetric LiDAR.

	Orthophoto	Terrestrial LiDAR	Bathymetric LiDAR
Horizontal Accuracy	7.6-foot horizontal accuracy (4.4 foot RMSE)	3.8-foot horizontal accuracy (2.2 foot RMSE)	Order 1 Hydrographic Data described in the IHO Standards for Hydrographic Surveys
Vertical Accuracy	Based upon digital elevation model	.6-foot fundamental vertical accuracy	Order 1 Hydrographic Data described in the IHO Standards for Hydrographic Surveys
Projection	Florida State Plane US Feet NAD83/HARN	Florida State Plane US Feet NAD83/HARN and/or Geographic NAD83/HARN	Florida State Plane US Feet NAD83/HARN and/or Geographic NAD83/HARN
Post-spacing / pixel size	1 foot	4 foot	5 meter
Format	GeoTIFF and compressed	LAS 1.1	LAS 1.1
Flight Season	Leaf-off	Leaf-off	Variable
Breaklines		Hydrologically correct breaklines	
Metadata	FGDC		
Contours	One and two foot		
LAS 1.1		Class1, Class 2, Class 7, Class 9, and Class 12	Class1, Class 7, Class 11, and Class 12

Sponsoring Agency

Florida Division of Emergency Management

Appendix A

Orthophotography Specifications

1 Collection of Data

All data must be collected and processed under the supervision of a Professional Surveyor and Mapper licensed in Florida and in accordance with the Minimum Technical Standards defined in Rule 61G17, Florida Administrative Code (http://www4.myflorida.com/dbpr/pro/surv/sm_fac_61g17.pdf).

2 Project Area

Project areas are to be made up of a collection of 5000-ft-by-5000-ft cells that serve as the tiling scheme for orthophoto deliverables. Please visit http://floridadisaster.org/gis/specifications to download this tiling scheme.

3 Specifications

3.1 Sensor

All imagery will be collected using an approved digital airborne imaging sensor. Sensors likely to be approved include the Leica ADS40, Vexcel UltraCAM, or Zeiss DMC airborne imaging sensor. If the Leica ADS40 sensor is used, it must have been retrofitted or originally manufactured to ensure that the infrared band aligns with the green and red bands.

3.2 Image Resolution

All raw imagery will have a nominal ground sampling resolution not to exceed 0.9 feet. Orthorectified images shall be delivered resampled to 1.0-foot pixels.

3.3 Horizontal Accuracy

Orthophotography shall meet or exceed a verified horizontal accuracy of 7.6 feet at the 95% confidence interval (4.4 feet RMSE) as specified in the FGDC Geospatial Positioning Accuracy Standards, Part 3: National Standard for Spatial Data Accuracy (http://www.fgdc.gov/standards/projects/FGDC-standards-projects/accuracy/part3/index_html). A minimum of 20 independently surveyed image checkpoints will be used for accuracy testing and control acceptance for every 500-square-mile subset of the project area. Check points shall be distributed so that points are spaced at intervals of at least 10% of the diagonal distance across the dataset and at least 20% of the points are located in each quadrant of the dataset. Correction for "building lean" in urban areas is not required.

3.4 Horizontal and Vertical Datum

Horizontal datum shall be referenced to the appropriate Florida State Plane Coordinate System. The horizontal datum shall be North American Datum of 1983/HARN adjustment in US Survey Feet. The vertical datum shall be referenced to the North American Vertical Datum of 1988 (NAVD 88). Geoid03 shall be used to convert ellipsoidal heights to orthometric heights.

3.5 Coordinate System and Projection

Orthophotography shall be projected to the appropriate Florida State Plane Coordinate System Zone, Units in US Survey Feet as shown in Attachment 5. The orthophoto geodatabase will be delivered in ESRI's 9.2 file geodatabase format and the default ESRI spatial extents for each State Plane Zone will be used.

3.6 Flight Season

Leaf-off aerial photography should be flown to minimize the area obstructed by tree canopy and other vegetation. Leaf-off season varies throughout the Florida and in some cases is not applicable. Data collection outside of this period is allowable for special projects such as post-event conditions and monitoring.

3.7 Image Quality

All images will be obtained under cloud-free conditions and will be free of obscuring haze, smoke, or other atmospheric conditions. Radiometric and color balancing of the imagery are described in the deliverables below. All images must be collected when the sun angle is greater than 30° to minimize shadows.

3.8 Photogrammetric Mapping Survey Control

The photogrammetric ground control must be adequate to support identified accuracy specifications. A survey report that documents and certifies the procedures and accuracies of the horizontal and vertical control, aircraft positioning systems, and aerial triangulation used in the photogrammetric mapping project shall be submitted.

The horizontal and vertical control shall be based on direct ties to National Geodetic Survey (NGS) control stations, National Spatial Reference System (NSRS). All geodetic control surveys, both horizontal and vertical, shall conform to the Standards and Specifications for Geodetic Control Networks (1984), Federal Geodetic Control Committee (FGCC). The horizontal control shall reference the North American Datum of 1983/ High Accuracy Reference Network (NAD83/HARN). Procedures used to establish horizontal photogrammetric ground control using

GPS measurements shall meet or exceed Second Order Horizontal Control as set forth by the FGCC, Geometric Geodetic Accuracy Standards, and Specifications for using GPS Relative Positioning Techniques, Version 5.0, May 1988. The vertical control shall reference the North American Vertical Datum of 1988 (NAVD88) using Geoid03 to convert ellipsoidal heights to orthometric heights. Procedures used to establish vertical control shall meet or exceed Third Order Vertical Control Accuracy Standards and Specifications. Procedures for GPS-Derived elevation differences shall meet or exceed Guidelines for Establishing GPS-Derived Ellipsoid Heights (Standards: 2 centimeters and 5 centimeters), NGS-58, November 1997, and/or Guidelines for Establishing GPS-Derived Orthometric Heights (Standards: 2 centimeters and 5 centimeters), NGS-59, October 2005.

Photogrammetric mapping consultants shall coordinate with contracting agencies in planning procedures to be used for all control surveys and shall submit a preliminary control layout map for approval.

All photogrammetric mapping procedures shall meet or exceed the Federal Emergency Management Agency's (FEMA) Guidelines and Specifications for Flood Hazard Mapping Partners, Appendix A: Guidance for Aerial Mapping and Surveying, April 2003, particularly Section A.5 Ground Control and Section A.6 Ground Surveys (http://www.fema.gov/plan/prevent/fhm/dl_cgs.shtm).

4 Digital Elevation Models and Existing Orthophotography

4.1 Digital Elevation Models

Any Digital Elevation Model (DEM) used must support the accuracy specifications identified. A final survey report shall be submitted and metadata supplied which documents the source and accuracy of the DEM used in the photogrammetric mapping project. Additionally, the final DEM generated for the development of orthophotos must be provided as an ASCII X,Y, Z file.

4.2 Existing Orthophotography

One goal of orthophotography data collection should be to maintain the highest possible consistency between data collected at different times. Existing orthophotography should be used to help achieve consistent color balancing.

5 Deliverables

All deliverables are considered public record. Any data collectors producing data will keep a copy of the original data for 5 years and must contact the funding agency before destroying the data.

5.1 Orthophoto Files

The clarity and quality of the imagery are of the highest importance for this specification. Coloration for all 24-bit images should mimic to the greatest extent possible that typically obtained using conventional natural color and color infrared film products. Samples of each image type representative of the land covers throughout the project area shall be submitted for approval before completing radiometric processing of the entire dataset.

- *Natural Color Imagery – 24 Bit.* 24 bit red, green blue (RGB) natural color imagery will be color balanced across the entire study area to the greatest extent possible to allow viewing of the image tiles as a visually seamless mosaic. Care should be taken during the radiometric processing to avoid loss of detail in shadows and overexposure on bright surfaces such as bare ground and light-colored building roofs. Imagery will be delivered in the following formats:
    - Uncompressed GeoTIFF with valid projection header information (one file per tile).
    - Compressed image formats such as Enhanced Compressed Wavelet (ECW), MrSID or JPEG2000.

- *Color Infrared Imagery (optional) – 24 Bit.* 24 bit RGB color infrared imagery will be radiometrically processed in a manner that preserves the original image characteristics to the greatest extent practical so that the data may be used for remote sensing analyses. Systematic radiometric corrections to reduce sun angle and sensor variations are desired. Corrections for seasonal variations in ground cover are not to be done; however, care should be taken to ensure that coloration of different vegetation types (e.g. deciduous, evergreen, etc.) is evident. Imagery will be delivered in the following formats:
    - Uncompressed GeoTIFF with valid projection header information (one file per tile).
    - Compressed image formats such as Enhanced Compressed Wavelet (ECW), MrSID or JPEG2000.

- *Image Cutlines* – A polygon feature class delineating homogenous image capture dates for the project area. To the greatest extent possible the image cutlines should conform to cell boundaries. The cutline feature class must have one date-format field named FLIGHTDATE that identifies the date the imagery was collected as defined by Attachment 1.

- *Orthophotography Checkpoints* – A point feature class that contains the minimum 20 independently surveyed image checkpoints used for accuracy testing and control for every 500-square-mile subset of the project area as defined by Attachment 1.

5.2 Image Tiling Scheme

All orthophotos will be delivered using the 5,000-ft-by-5,000-ft tiling scheme defined in the *ProjectName_Ortho_Project_Area* feature class which conforms to the statewide tiling scheme available for download at http://floridadisaster.org/gis/specifications. Tiles shall be contiguous and non-overlapping and will be suitable for creating a seamless image mosaic that includes no "no data" cells or gaps. Tiles shall be named using the following convention:

OPYYYY_CIR_*cellnum_bit*.TIF

where: OP stands for Orthophoto
CIR is for Color Infrared, NC is for Natural Color
YYYY is the year photo was acquired
Cellnum is appropriate CELLNUM values found in the *ProjectName_Ortho_Project_Area* feature class.
Bit is the number of bits in the imagery

ex: OP2006_NC_000279_24.TIF

A project tile footprint feature class as defined in Attachment 1 shall be delivered following the naming scheme *ProjectName_Ortho_Project_Area*. The footprint feature class must have one text field named CELLNUM (as described above) that identifies the tile number as defined by Attachment 1.

5.3 Metadata

Metadata compliant with the Federal Geographic Data Committee's (FGDC) Content Standard for Spatial Metadata in an ArcCatalog compatible XML format will be delivered. At a minimum the metadata will include the following information:

- Image collection date for each lift.
- Sensor description.
- DEM source information.
- Processing software.
- Processing methodology.
- Projection information (horizontal and vertical datums).
- Positional accuracy and procedures used to determine accuracy.

Metadata will apply to the project as a whole and not to each individual data tile.

5.4 Media

All imagery will be delivered on portable USB or Firewire drives (250 GB minimum) that are labeled with the project name, data collector, and funding agency. Survey reports and metadata will be delivered in printed format and as PDF files on CD-ROM.

5.5 Survey Report

A survey report shall be prepared to document all photogrammetric ground control, aircraft global positioning system, aerial triangulation, DEM creation, photo identification (horizontal and vertical) check points, and orthorectification processes used in the project. The Survey Report must also include an accuracy report and statement complying with FGDC Geospatial Positioning Accuracy Standards, National Standard for Spatial Data Accuracy (NSSDA). The Survey Report must include a map delineating flight line locations and flight dates. This report must comply with relevant Minimal Technical Standards for Professional Surveying and Mapping done in Florida and be delivered in hardcopy and PDF formats; the survey report shall include items outlined in Attachment 2 - Surveying and Mapping Reporting Guidelines for Professional Photogrammetric Mapping Services.

Orthophotography Deliverable Summary

Copies	Description	Resolution (FT)	Datum	Format	Notes
	Natural Color 24-Bit Cells	1.0	NAD83/HARN	GeoTIFF, ECW (optional)	All Cells
	Color Infrared 24-Bit Cells (optional)	1.0	NAD83/HARN	GeoTIFF, ECW (optional)	All Cells
2	Survey report			Hardcopy	
1	Survey report			PDF	
1	Metadata file per feature class			ArcGIS XML	
1	Cutline feature class with image dates		NAD83/HARN	ArcGIS File Geodatabase	See Attachment 1
1	Checkpoint feature class		NAD83/HARN	ArcGIS File Geodatabase	See Attachment 1 Vertical NAVD88
1	Project tiling footprint feature class		NAD83/HARN	ArcGIS File Geodatabase	See Attachment 1
1	DEM for orthophotography generation		NAD83/HARN	ASCII X,Y,Z	Vertical NAVD88

Appendix B

Terrestrial LiDAR Specifications

1 Collection of Data

All data must be collected and processed under the supervision of a Professional Surveyor and Mapper licensed in Florida and in accordance with the Minimum Technical Standards defined in Rule 61G17, Florida Administrative Code (http://www4.myflorida.com/dbpr/pro/surv/sm_fac_61g17.pdf). All LiDAR data must meet or exceed the primary set of specifications defined in this document. The LiDAR data must also meet or exceed the Federal Emergency Management Agency's (FEMA) Guidelines and Specifications for Flood Hazard Mapping Partners, Appendix A: Guidance for Aerial Mapping and Surveying, April 2003 (http://www.fema.gov/pdf/fhm/frm_gsaa.pdf).

2 Project Area

Project areas are to be made up of a collection of 5000-ft-by-5000-ft cells that serve as the tiling scheme for LiDAR and topographic data deliverables. Please visit http://floridadisaster.org/gis/specifications to download shapefiles for this tiling scheme.

3 Existing Terrestrial LiDAR Data

Where possible, all adjacent mass point, breakline, and orthophoto data collected by previous projects, including survey reports, will be used to tie data collected to that collected by previous projects so as to minimize differences in surface elevations at the intersecting seams of the project areas.

4 Specifications

4.1 Sensor

All LiDAR data will be collected using an approved sensor with a maximum field of view (FOV) of 40^0 (20^0 off nadir).

4.2 Post Spacing

The LiDAR cloud will be collected at a maximum post spacing of 4 feet in unobscured areas for random point data. As defined here, *unobscured areas* are those which do not contain structures, vegetation, or other surface features of sufficient density to make it difficult to obtain bare earth postings at the specified target density.

4.3 Sensor Calibration

Routine sensor calibration and maintenance are required to ensure proper function of the LiDAR system. Any requests by funding agencies to submit evidence that the sensor system was calibrated before the project began to identify and correct systematic errors must be met.

Bore-sight calibration should be performed at least twice during each project, at the beginning and the end of a project. Additional bore-sight calibrations should be done as necessary to ensure accuracy.

4.4 Horizontal and Vertical Accuracy

Horizontal accuracy shall be tested to meet or exceed a 3.8-foot horizontal accuracy at the 95% confidence level using RMSE(r) x 1.7308 as defined by the FGDC Geospatial Positioning Accuracy Standards, Part 3: NSSDA. Methodology, results, and findings of horizontal accuracy testing shall be disclosed in the Survey Report.

The vertical accuracy testing for LiDAR data over well-defined surfaces shall meet or exceed requirements as set forth in the Federal Geographic Data Committee's (FGDC) Geospatial Positioning Accuracy Standards, Part 3: National Standard for Spatial Data Accuracy (NSSDA). Vertical accuracies at the 95% confidence level for flat terrain are required, assuming all systematic errors have been eliminated to the greatest extent possible and the errors are normally distributed. Fundamental vertical accuracy shall be tested to meet a 0.60 - foot fundamental accuracy at the 95% confidence level using RMSE(z) x 1.9600 (as defined by the "ASPRS Guidelines: Vertical Accuracy Reporting for Lidar Data"). This guideline implements the NSSDA for testing of LiDAR data.

4.5 Horizontal and Vertical Datum

Horizontal datum shall be referenced to the North American Datum of 1983/HARN adjustment. Vertical datum shall be referenced to the North American Vertical Datum of 1988 (NAVD 88). Geoid03 shall be used to perform conversions from ellipsoidal heights to orthometric heights

4.6 Coordinate System and Projection

Terrestrial LiDAR data shall be projected to the appropriate Florida State Plane Coordinate System Zone, Units in US Survey Feet as shown in Attachment 5. The topographic geodatabase will be delivered in ESRI's 9.2 file geodatabase format and the default ESRI spatial extents for each State Plane Zone will be used.

4.7 Flight Season

Leaf-off aerial LiDAR should be flown to minimize the area obstructed by tree canopy and other vegetation. Leaf-off season varies throughout the state and in some cases is not applicable. Data collection outside of this period is allowable for special projects such as post-event conditions and monitoring.

4.8 LiDAR Mapping Survey Control

The LiDAR ground control must be adequate to support the accuracy specifications identified for particular projects. A survey report that documents and certifies the procedures and accuracies of the horizontal and vertical control, aircraft positioning systems, and system calibration procedures used in the LiDAR mapping project shall be created. Baseline distances for GPS ground control shall not exceed 20 miles.

The horizontal and vertical control shall be based on direct ties to National Geodetic Survey (NGS) control stations, National Spatial Reference System (NSRS). All geodetic control surveys, both horizontal and vertical, shall conform to the Standards and Specifications for Geodetic Control Networks (1984), Federal Geodetic Control Committee (FGCC). The horizontal control shall reference the North American Datum of 1983/ High Accuracy Reference Network (NAD83/HARN). Procedures used to establish horizontal photogrammetric ground control using GPS measurements shall meet or exceed Second Order Horizontal Control as set forth by the FGCC, Geometric Geodetic Accuracy Standards and Specifications for using GPS Relative Positioning Techniques, Version 5.0, May 1988. The vertical control shall reference the North American Vertical Datum of 1988 (NAVD88) using Geoid03 to perform conversions from ellipsoidal heights to orthometric heights. Procedures used to establish vertical control shall meet or exceed Third Order Vertical Control Accuracy Standards and Specifications. Procedures for GPS-Derived elevation differences shall meet or exceed Guidelines for Establishing GPS-Derived Ellipsoid Heights (Standards: 2 centimeters and 5 centimeters), NGS-58, November 1997, and/or Guidelines for Establishing GPS-Derived Orthometric Heights (Standards: 2 centimeters and 5 centimeters), NGS-59, October 2005.

All mapping shall be coordinated in planning procedures and methodology used for all control surveys. Mapping shall meet or exceed FEMA Flood Hazard Mapping Program, Guidelines and Specifications for Flood Hazard Mapping Partners, Appendix A, Section A.5 Ground Control, and Section A.6 Ground Surveys.

5 Deliverables

5.1 Mass Points

Mass point data shall be delivered in LAS files compatible with the LAS Specification 1.1 format and must meet the requirements identified within this specification including header blocks, variable length records, and point data. Required items not specifically noted as required in the LAS 1.1 Specification are defined in the following sections. The mass point data shall not contain any holidays in the data as a result of missing mission coverage or system malfunction. The classification code for these files will follow the LAS 1.1 format and will include the following:

- Class 1 = Unclassified
- Class 2 = Ground
- Class 7 = Noise
- Class 9 = Water
- Class 12 = Overlap

- Class 1, 2, 7, and 9 will include LiDAR points in overlapping flight lines. Class 12 will be used for LiDAR points, in areas of overlapping flight lines, which have been deliberately deleted and removed from all other classes because of their reduced accuracy possibly due to their off-nadir position.
- Class 1 will be used for all features that do not fit into the Classes 2, 7, 9, or 12 including vegetation, buildings, etc.
- Shorelines of water bodies shall be captured as breaklines and LiDAR measurements inside of water bodies will be classified as water in the LAS deliverable.
- A complete LiDAR cloud shall be delivered where the bare earth classification (Class 2) is free of artifacts not representing the earth's surface (cell towers, birds, etc.). These artifacts shall be classified as Class 7 – Noise as defined above.
- Only the bare earth classification (Class 2) shall be loaded into the MASSPOINT feature class.

Public header information must be contained as specified within the LAS 1.1 file specification. In addition to the LAS 1.1 required fields, the following items are required to be populated:

Project ID – GUID data 4:	project identifier
File Creation Day of Year:	1
File Creation Year:	year created

The project identifier will be populated as follows:
Contractor_TaskOrder_[delivery block name or number]

GUID data 4 is limited to 8 characters; abbreviate as necessary.

Ex: ACME_A_5

- The fields *File Creation Day of Year* and *File Creation Year* are the file creation date. This date will represent the day the final LAS file is generated for submittal.

- Projection information for the point data must be specified in the Variable Length Records using the GeoTIFF specification as the model as defined in the LAS 1.1 file specification.

- The Point Data Record Format shall follow the Point Data Record Format 1 as defined in the LAS 1.1 Specification. In addition to the required items, the Intensity shall be populated.

5.2 Breaklines

Breaklines shall be delineated to ensure the Digital Terrain Model (DTM) is hydrologically correct. *Hydrologically enforced elevation data* is defined as "Hydroenforced TIN's, DEM's, or contours ensure that top surfaces of bridges and culverts are cut by stream breaklines so that computer models will accurately represent drainage flow" in FEMA's Appendix A A.4.10. Proposed breakline compilation techniques shall be defined and approved before data collection. In all cases, the LiDAR takes precedence over the orthophotography for the existence of a feature and horizontal placement of a breakline. The following guidelines will be used when developing breaklines:

- Breaklines will be delivered in ArcGIS geodatabase format as defined by Attachment 2 – Topographic Geodatabase Design. Separate feature classes must be delivered for each breakline feature type defined below. Each feature class contains a DATESTAMP_DT field which shall be populated with the date the feature was added to the geodatabase.

- Feature classes must be contained within a feature dataset with proper horizontal and vertical spatial references defined. Feature classes must be Z-enabled where defined as three-dimensional breakline features below. Those features captured as two-dimensional breaklines must have a floating point ELEVATION attribute.

- Breaklines will be captured for hydrologically significant features as appropriate to support the development of a terrain surface meeting a 0.6-foot fundamental vertical accuracy at the 95% confidence level. Fundamental vertical accuracy is computed in open terrain using the formula RMSE(z) x 1.9600 (as defined by the "ASPRS Guidelines: Vertical Accuracy Reporting for Lidar Data." This guideline implements the National Standard for Spatial Data Accuracy (NSSDA) for testing of LiDAR data.

Breakline features will be classified and separated as follows:

5.2.1.1 Closed Water Body Features

Land/water boundaries of constant elevation water bodies (lakes, reservoirs, etc.) will be delivered as closed polygons with a constant elevation that reflects a best estimate of the water elevation at the time the data were captured. Water body features will be captured for features one-half acres in size or greater. Water bodies may be captured as two- or three-dimensional breaklines.

Closed Water Body Features will be compiled as 2D features with a single elevation. An Island within a Closed Water Body Feature will also have a “donut polygon” compiled in addition to an Island polygon.

For docks or piers following (not perpendicular to) the Closed Water Body Features please reference docks or piers under section 5.2.1.3 entitled Coastal Shorelines.

5.2.1.2 Linear Hydrographic Features

Linear hydrographic features (streams, shorelines, canals, swales, embankments, etc.) will be delivered as breaklines with varying elevations. All stream/river features that are 0.5 miles or greater in length will be captured. Features that are 8 feet or less in width shall be captured as single breakline features. Features that are greater than 8 feet in width shall be captured as double line features. All features will be captured as three-dimensional breaklines. Carry linear hydrographic features through and/or under bridges to the best of the operator’s ability to see.

Embankments may be collected as linear hydrographic features if it is a very sharp feature, or can be collected at a Soft Feature.

For docks or piers following (not perpendicular to) the Linear Hydrographic Features please reference docks or piers under section 5.2.1.3 entitled Coastal Shorelines.

5.2.1.3 Coastal Shorelines

Coastal shorelines can be captured as two-dimensional linear features with the exception of manmade features with varying heights such as seawalls which must be captured as three-dimensional breaklines. Coastal breaklines will merge seamlessly with linear hydrographic features (5.2.1.2) at the approximate maximum extent of tidal influence. The coastal breakline will delineate the land water interface using the LiDAR data as reference. In flight line boundary areas with tidal variation the coastal shoreline may require some feathering or edge matching to ensure a smooth transition. Orthophotography will not be used to delineate this shoreline.

Docks or piers – These guidelines apply only to docks or piers that follow the coastline or water’s edge, not for docks or piers that extend perpendicular from the land into the water. If it can be reasonably determined where the edge of water most probably falls, beneath the dock or pier, then the edge of water will be collected at the elevation of the water where it can be directly measured. If there is a clearly-indicated headwall or bulkhead adjacent to the dock or pier and it is evident that the waterline is most probably adjacent to the headwall or bulkhead, then the water line will follow the headwall or bulkhead at the elevation of the water where it can be directly measured. If there is no clear indication of the location of the water's edge beneath the dock or pier, then the edge of water will follow the outer edge of the dock or pier as it is adjacent to the water, at the measured elevation of the water.

5.2.1.4 Road Features

Both sides of paved road features, not including bridges and overpasses, shall be captured as edge-of-pavement breaklines. These features will be captured as three-dimensional breaklines.

5.2.1.5 Soft Features

In areas where the LiDAR mass points are not sufficient to create a hydrologically correct DTM, soft features such as ridges, valleys, top of banks, etc. shall be captured as soft breaklines of varying elevations. These features will be captured as three-dimensional breaklines. Soft features may also include embankments.

5.2.1.6 Low Confidence Areas

Low Confidence Areas are defined as vegetated areas that are considered obscured to the extent that adequate vertical data cannot be clearly determined to accurately define the DTM. These features shall be captured as two-dimensional closed polygon features. These features are for reference information indicating areas where the vertical data may not meet the data accuracy requirements due to heavy vegetation.

5.2.1.7 Island Features

The shoreline of islands within water bodies shall be captured as two-dimensional breaklines in coastal and/or tidally influenced areas and as three-dimensional breaklines in non-tidally influenced areas. Island features will be captured for features one-half acre in size or greater. These breaklines will be delivered as closed polygons with constant elevation.

An island within a Closed Water Body Feature will also have a "donut polygon" compiled in addition to an island polygon.

For docks or piers following (not perpendicular to) the Island Features please reference docks or piers under section 5.2.1.3 entitled Coastal Shorelines.
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5.2.1.8 Overpasses and Bridges

Overpass and bridge features will be captured as three-dimensional breaklines, capturing the edge of pavement on the bridge (rather than elevation of guard rails or other bridge surfaces).

5.3 Contours

Two-foot contours that are certified to meet or exceed National Map Accuracy Standards shall be created. Two-foot contours within low confidence areas shall be attributed as such and are not required to meet National Map Accuracy Standards. Additionally, 1-foot contours will be delivered for graphical purposes. Contours must be delivered in the ArcGIS geodatabase format as defined by Attachment 2 –Topographic Geodatabase Design for contours with separate feature classes for 1 and 2 foot contours. The feature classes will contain an elevation field and a contour type field with the specified domain. While contours should be moderately aesthetically pleasing to the layperson, this deliverable is not intended to develop high-quality cartographic contours. However, an acceptable level of smoothing should be established and approved and be consistent across all deliverables.

The contour domain contains the following eight values:

1. Intermediate
2. Supplementary
3. Depression
4. Index
5. Intermediate Obscured
6. Supplementary Obscured
7. Depression Obscured
8. Index Obscured

Index contours are defined below and will take precedence over the depression classification. Supplementary contours are only required for the Contour_2FT feature class and are not required for the Contour_1FT feature class. The contour type definitions listed below reference the USGS Digital Line Graph Standards (Part 7: Hypsography).
http://rockyweb.cr.usgs.gov/nmpstds/dlgstds.html

> **Intermediate contours** (the three or four lines between adjacent index contours) are about half the line weight of index contours. They are normally continuous throughout a map, but may be dropped or joined with an index contour where the slope is steep and where there is insufficient space to show all of the intermediate lines.
>
> **Supplementary contours** are used to portray important relief features that would otherwise not be shown by the index and intermediate contours (basic contours). They are normally added only in areas of low relief, but they may also be used in rugged terrain to emphasize features. Supplementary contours are shown as screened lines so that they are distinguishable from the basic contours, yet not unduly prominent on the published map.

Depression contours are closed contours that surround a basin or sink. They are shown by right-angle ticks placed on the contour lines, pointed inward (down slope). Fill contours are a special type of depression contours, used to indicate an area that has been filled to support a road or railway grade.

Index contours are defined as every 5th contour line. For example, with the Contour_2FT feature class, the first positive intermediate contour would be 0 with the following index contours at 10, 20, 30 feet, etc.

5.4 LiDAR Tiling Scheme

All LiDAR point data must be delivered within the 5000-ft-by-5000-ft tiling scheme defined in the *ProjectName_Terrestrial_LiDAR_Project_Area* feature class. Tiles shall be contiguous and non-overlapping and will be suitable for creating seamless topographic data mosaics that contain no "no data" areas. Tiles shall be named as follows:

LIDYYYY_*cellnum*.LAS

where LID stands for LiDAR
YYYY is the year
cellnum is appropriate CELLNUM values found in the standard tiling feature class.

ex: LID2006_00279.LAS

A project tile footprint feature class as defined in Attachment 3 shall be delivered following the naming scheme *ProjectName_Terrestrial_LiDAR_Project_Area*. The footprint feature class must have one text field named CELLNUM (as described above) that identifies the tile number as defined by Attachment 3.

5.5 Metadata

Metadata compliant with the Federal Geographic Data Committee's (FGDC) Content Standard for Spatial Metadata in an ArcCatalog-compatible XML format will be delivered. Metadata should be in accordance with recommendation of the National Digital Elevation Program Guidelines for Digital Elevation Data, Version 1. The following minimum guidelines must be adhered to in the metadata:

- There should be one set of metadata per feature class and one set of metadata for each group of LiDAR LAS files corresponding to a homogenous delivery block.
- Metadata must be delivered in a format compatible with ArcGIS 9.x.

- The metadata recommendations defined in Guidelines for Digital Elevation Data, Version 1.0 (http://www.ndep.gov/NDEP_Elevation_Guidelines_Ver1_10May2004.pdf) can serve as a model for the metadata. Metadata may be expanded upon as appropriate.

- Copies of all survey reports including the Minimum Technical Standards (MTS report) must be delivered in PDF format and will be used as attachments to the FGDC metadata.

Metadata will apply to the project as a whole and not to each individual data tile.

5.6 Media

All LiDAR data will be delivered on portable USB or Firewire drives (250 GB minimum) that are labeled with the project name, data collector, and funding agency. Survey reports and metadata will be delivered in printed format and as PDF files on CD-ROM.

5.7 Vertical Accuracy Report

A vertical accuracy report that is based upon the comparison of a minimum of 30 ground measurements for each land cover classification listed below shall be produced. The land cover classifications listed below are suggested standard categories. However, the land cover categories should change to reflect the predominant land cover in each project area. In cases where there are insufficient representative amounts of a particular land cover, this list may be modified with funding agency approval. The ground cover measurements distributed through each project area will be collected for each of the following land cover categories:

1. Bare-earth and low grass
2. Brush lands and low trees
3. Forested areas fully covered by trees
4. Urban areas

Vertical accuracy guidelines are as follows from FEMA's Appendix A:

In category 1, the $RMSE_z$ must be $\leq$ .30 ft ($Accuracy_z \leq$ .60 feet)
In category 2, the $RMSE_z$ should be $\leq$ .61 ft ($Accuracy_z \leq$ 1.19 feet)
In category 3, the $RMSE_z$ should be $\leq$ .61 ft ($Accuracy_z \leq$ 1.19 feet)
In category 4, the $RMSE_z$ should be $\leq$ .61 ft ($Accuracy_z \leq$ 1.19 feet)
In all categories combined, the $RMSE_z$ should be $\leq$ .61 ft ($Accuracy_z \leq$ 1.19 feet)

The test points in open terrain (bare earth and low grass) will be used to calculate the Fundamental Vertical Accuracy (FVA) and should be less than or equal to .60 feet. Supplemental Vertical Accuracies (SVA) will be calculated for each of the other land cover classes and should be less than or equal to 1.19 feet. Additionally, the overall Consolidated Vertical Accuracy

(CVA) for all classes should be less than or equal to 1.19 feet. In cases where more than 30 checkpoints are collected in a particular land cover class, vertical accuracy reporting is to be based on the 30 worst or least-accurate checkpoints according to ASPRS guidelines. Additionally, for each 500 square miles of topographic LiDAR data to be collected, a separate set of 120 test points shall be surveyed and used for accuracy testing.

Accuracy inspections shall be made in flat or gradually sloping areas to minimize potential errors related to horizontal map accuracies. Test points will be well distributed throughout the project area to the greatest degree possible. ASPRS, NSSDA, and NDEP all recommend the following guidelines:

> *Check points may be distributed more densely in the vicinity of important features and more sparsely in areas that are of little or no interest. When the distribution of error is likely to be nonrandom, it may be desirable to locate checkpoints to correspond to the error distribution. For a dataset covering a rectangular area that is believed to have uniform positional accuracy, check points may be distributed so that points are spaced at intervals of at least 10 percent of the diagonal distance across the dataset and at least 20 percent of the points are located in each quadrant of the dataset.*

Accuracy testing and reports will be done in accordance with the specifications of the FGDC Geospatial Positioning Accuracy Standards, Part 3: National Standard for Spatial Data Accuracy (NSSDA). Checkpoint surveys for vertical accuracy testing shall be made in accordance with FEMA Appendix A. Section A.6.4 Checkpoint Surveys. The vertical accuracy test points and the survey ground control points will be delivered as an ArcGIS point geodatabase as defined by Attachment 3.

Terrestrial LiDAR Deliverable Summary Table

Copies	Description	Resolution (FT)	Datum	Format	Notes
	Terrestrial LiDAR				
1	LiDAR Mass Points	4	NAD83/HARN	LAS	
1	LiDAR Mass points (Class 2 – ground only)		NAD83/HARN	ArcGIS File Geodatabase	See Attachment 3 Vertical NAVD88
1	Digital Breakline Feature Dataset		NAD83/HARN	ArcGIS File Geodatabase	See Attachment 3 Vertical NAVD88
1	Contours feature class	2.0	NAD83/HARN	ArcGIS File Geodatabase	See Attachment 3 Vertical NAVD88
1	Contours feature class	1.0	NAD83/HARN	ArcGIS File Geodatabase	See Attachment 3 Vertical NAVD88
2	Survey Report			Hardcopy	
1	Survey Report			PDF	
3	LiDAR Processing Report			Hardcopy	
1	LiDAR Processing Report			PDF	
3	Vertical Accuracy Report			Hardcopy	
1	Vertical Accuracy Report			PDF	
1	Metadata file per feature class			ArcGIS XML	
1	Survey Ground Control feature class		NAD83/HARN	ArcGIS File Geodatabase	See Attachment 3 Vertical NAVD88
1	Vertical Accuracy Test Points feature class		NAD83/HARN	ArcGIS File Geodatabase	See Attachment 3 Vertical NAVD88
1	Project tiling footprint feature class		NAD83/HARN	ArcGIS File Geodatabase	See Attachment 3

Appendix C

Bathymetric LiDAR Specifications

1 Collection of Data

All data must be collected and processed under the supervision of a Professional Surveyor and Mapper licensed in Florida and in accordance with the Minimum Technical Standards defined in Rule 61G17, Florida Administrative Code (http://www4.myflorida.com/dbpr/pro/surv/sm_fac_61g17.pdf). All bathymetric LiDAR data will be processed to meet or exceed protocols for Order 1 Hydrographic Data described in the IHO Standards for Hydrographic Surveys, 4th Edition, April 1998, Special Publication S-44 (http://www.iho.shom.fr), or as described below:

- All necessary computations to verify the accuracy of all measurements and apply the proper theory of location in accordance with the law or precedent shall be performed.

- Computation and tabulation of the horizontal and vertical positions to include the application of any GPS kinematic data, tidal, or water level corrections for all data collected shall be performed.

- Data shall be acquired during aerial flights at times that minimize heavy sea states and water turbidities.

- LiDAR data should be free of any condition which may obscure terrestrial features or sea-bottom feature detection to a water depth of 50 meters (or laser extinction), including, but not limited to clouds, sun glint, haze, smoke, smog, rain, heavy seas, suspended sediment, etc.

- Flight lines should be flown to optimize efficiency. At least 5% of the flight lines must be flown orthogonally to the direction of predominant flight lines to evaluate the horizontal and vertical accuracy of the LiDAR data and to help identify systematic errors. Flight lines at or near the land water interface shall be flown within 2 hours of high tide to ensure sufficient overlap of the topographic and bathymetric LiDAR data.

- Continuous flight lines are preferred. If patching is required, flight lines shall begin 1 to 2 km early, be flown in the same direction, at the same altitude, and as soon as possible after originally flown.

- The LiDAR cloud will be collected at a maximum final post spacing of 5 meters for random point data. *Obscured areas* are those containing structures, vegetation or other surface features that are of sufficient density to make it impossible to obtain bare seafloor postings.

- The LiDAR system shall record the “true” last pulse. For example, in a system that collects three returns, the third return must correspond to the last detectable pulse within the return waveform to maximize the probability of getting the true (or closest to true) terrain measurement below the vegetation or seafloor feature; it is not acceptable to simply record the first three events.

- At least three flight lines shall be acquired across repeatable and verifiable surfaces (e.g., a dock or shallow-water seafloor feature) to compare the overlapping swaths to identify any systematic errors. The contractor should also acquire at least 5% of the flight lines orthogonal to an existing flight line to evaluate the geometric co-registration of the bathymetric LiDAR data.

All LiDAR sensor malfunctions shall be recorded and the funding agency notified. A *malfunction* is defined as a failure anywhere in the sensor that causes an interruption to the normal operation of the unit. Also, any malfunctions of the GPS or IMU collection systems must be recorded and reported.

2 Project Area

Project areas are to be made up of a collection of 5000-ft-by-5000-ft cells that serve as the tiling scheme for LiDAR and bathymetric data deliverables. Please visit http://floridadisaster.org/gis/specifications to download shapefiles for this grid.

3 Existing Bathymetric LiDAR Data

Where possible, adjacent mass points collected by previous projects, including survey reports, will be used to tie data collected to that collected by previous projects so as to minimize differences in surface elevations at the intersecting seams of the project areas.

4 Specifications

4.1 Sensors and Equipment

Inertial Measurement Unit - The Inertial Measurement Unit (IMU) employed in the LiDAR system shall meet or exceed the following performance specifications:

- Accuracy in roll and pitch (RMS): 0.015 degrees
- Accuracy in heading (RMS): 0.050 degrees

LiDAR Sensors – Before the project begins, certifications that preventive maintenance and factory calibration have been satisfactorily completed within the last 2 years for the LiDAR sensors must be supplied to the funding agency.

Aircraft - The type of aircraft and the tail number of the aircraft used shall be stated on the Flight Log and all aircraft used shall be maintained and operated in accordance with all regulations required by the Federal Aviation Administration. Any inspections or maintenance of aircraft which results in missed data collection shall not be considered as an excusable cause for delay. Aircraft must have a proven service ceiling, with operating load (fuel, crew, sensors, and other required equipment) of not less than the highest altitude required to acquire the data.

4.2 Post Spacing

The LiDAR cloud will be collected at a maximum post spacing of 5-x-5-meter spacing in NAD 83/HARN, NAVD88, classified into the appropriate classes from Section 5.1.

4.3 System Calibration

Overall, all imaging systems shall be tuned to meet the performance specifications for the model being calibrated. The data collector shall ensure that factory calibration has been performed for the LiDAR system within the 24-month period preceding the data collection. Recalibration is required at intervals no greater than 24 months. Data collectors who wish to apply for a waiver to this requirement must send a written request stating the date of the last factory calibration and a detailed justification for the waiver.

Data collectors shall determine the LiDAR sensor-to-GPS-antenna offset vector components ("lever arm"): the offset vector shall be determined with an absolute accuracy (1F) of 1.0 cm or better in each component. Measurements shall be referenced to the antenna phase center. The offset vector components shall be re-determined each time the sensor or aircraft GPS antenna is moved or repositioned in any way.

To achieve maximum georegistration accuracy of the LiDAR, data collectors shall conduct: (1) sensor timing analysis, (2) navigation calibration, and (3) a spatial accuracy test before data collection. Georegistration factors (1) and (2) apply only to the use of airborne remote sensing data collection. The calibration procedures shall involve multiple (e.g. three) flights of the same area at different headings and altitude. The calibration area must also contain spatial features that are discernible in the imagery at a 1:6,000 viewing scale, preferably with sub-pixel accuracy.

Current calibration (both radiometric and geometric) reports for each LiDAR system used shall be supplied to the funding agency at the beginning and end of the project. Inadequate calibration or incomplete calibration reports may be cause for rejection of the data by the funding agency. The calibration reports shall cover each of the following types of calibration:

- LiDAR Factory Calibration – Factory calibration of the topographic and bathymetric LiDAR systems shall address both radiometric and geometric performance and calibration. The following briefly describes the parameters to be tested according to test procedures defined by the manufacturer. Some of these procedures and parameters may be unique to a manufacturer since hardware varies from manufacturer to manufacturer.

- LiDAR Radiometric Calibration (sensor response) - The output of the laser must be shown to meet specifications for pulse energy, pulse width, rise time, frequency, and divergence for the model of LiDAR being tested:
    - Measure the receiver response from a reference target to ensure that the response level of the receiver is within specification for the model of LiDAR system being tested.
    - Check the alignment between transmitter and receiver and certify that the alignment is optimized and within specification.
    - Measure T0 response of receiver (i.e., the response at the time the laser is fired) to ensure that the T0 level is within specification.
- Range Calibration – Determine rangefinder calibrations including first/last range offsets, temperature dependence, and frequency offset of rangefinder electronics, range dependence on return signal strength. Provide updated calibration values.
- Scanner Calibration – Verify that scanner passes accuracy and repeatability criteria. Provide updated scanner calibration values for scanner offset and scale.
- Position Orientation System (POS)-Laser Alignment – Check alignment of output beam and POS. Also, provide updated POS misalignment angles.
- Field Calibration - Field calibration is performed by the system operator through flights over a calibration site that has been accurately surveyed using GPS or conventional survey techniques such as triangulation or spirit leveling. Typically, the calibration site may include a large flat-roofed building whose corners have been accurately surveyed with GPS and a large flat parking lot or runway. The calibration may include flights over the site in opposing directions, as well as cross flights. The field calibration is used to determine corrections to the roll, pitch, and scale calibration parameters.

4.4 Horizontal and Vertical Accuracy

The bathymetric LiDAR data will meet or exceed protocols for Order 1 hydrographic data described in the IHO Standards for Hydrographic Surveys, 4th Edition, April 1998, Special Publication S-44 (http://www.iho.shom.fr). Any horizontal control used for this project shall be referenced to an NGS published monument with a position quality of Class B or better. Vertical Datum shall be referenced to the North American Vertical Datum of 1988 (NAVD 88) using Geoid03 to perform conversions from ellipsoidal heights to orthometric heights. Any vertical control used for this project shall be referenced to a National Geodetic Survey (NGS) published monument with a position quality of at least First Order, Class I. Bathymetric LiDAR data from different flight lines shall be consistent across flight lines, i.e., there is no vertical offset between adjacent flight lines.

4.5 Horizontal and Vertical Datum

Horizontal Datum shall be referenced to the appropriate North American Datum of 1983/HARN adjustment. Any horizontal control used for this project shall be referenced to an NGS-published monument with a position quality of Class B or better. Vertical Datum shall be referenced to the North American Vertical Datum of 1988 (NAVD 88) using Geoid03 to perform conversions from ellipsoidal heights to orthometric heights. Any vertical control used for this project shall be referenced to an NGS-published monument with a position quality of at least First Order, Class I.

4.6 Coordinate System and Projection

The data shall be delivered in two projections/coordinate systems. One set of deliverables will be projected to the appropriate Florida State Plane Coordinate System Zone, Units in US Survey Feet. The second set of deliverables will be delivered in a Geographic Coordinate System. As stated in Section 4.5, both deliverables will be referenced to the NAD83 HARN datum. The bathymetric geodatabase will be delivered in ESRI's 9.2 file geodatabase format and the default ESRI spatial extents for each State Plane Zone will be used.

4.7 Flight Window and Mission Planning

The optimal flying season for bathymetric LiDAR varies throughout Florida depending on the effects of weather, water clarity, and other factors on light extinction. May through June is the recommended time for the east coast and Florida Keys. May is the recommended time for the west coast, and April is the recommended time for the panhandle. As conditions will vary across years, data collectors should work with the funding agency to acquire the bathymetric LiDAR during optimal periods.

Near-shore and estuarine LiDAR data will be collected within 2 hours of high-tide. Data collectors shall produce a table showing the predicted times of the time/tide windows and the predicted times of the data acquisition for review. Data collectors shall be sure to take into account time zones and daylight savings time and to use Universal Time Coordinate (UTC) time. Inclement weather conditions will be avoided. If weather or tidal conditions are not acceptable to meet this window, data collectors must receive written approval from the funding agency before flying.

- Overlap - Adjacent swaths shall have a minimum overlap of no less than 20% of the mean swath width.

- Flight Direction - Flight lines over the area should be flown in such a way as to optimize efficiency. Several flight lines should be flown in opposite or orthogonal directions to help identify systematic errors.

- LiDAR sensors shall not be flown at an altitude higher than the altitude indicated in the manufacturer's specifications or that results in "drop-outs" (e.g., pulses for which no return is received.) appearing in the LiDAR data.

4.8 Bathymetric LiDAR Survey Plan Report

Before data acquisition, data collectors shall submit paper map(s) showing all proposed flight lines and include coverage, scale, tide stage, proposed ground control, and project area boundaries. Also included shall be information about scan angle, Pulse Repetition Frequency (PRF), flying height, and flying speed over ground or water. The base map shall be the largest scale nautical chart covering the entire project area, if possible. Similar map(s) showing the actual flight lines shall be included in the Final Report. Data collectors shall comply with all required Federal Aviation Administration Regulations, including obtaining all required clearances.

4.9 LiDAR Mapping Survey Control

The LiDAR ground control must be adequate to support the accuracy specifications identified for this project. Data collectors shall submit a survey report that documents and certifies the procedures and accuracies of the horizontal and vertical control, aircraft positioning systems, and system calibration procedures used in the LiDAR mapping project. Baseline distances for GPS ground control shall not exceed 20 miles.

The horizontal and vertical control shall be based on direct ties to National Geodetic Survey (NGS) control stations, National Spatial Reference System (NSRS). All geodetic control surveys, both horizontal and vertical, shall conform to the Standards and Specifications for Geodetic Control Networks (1984), Federal Geodetic Control Committee (FGCC). The horizontal control shall reference the North American Datum of 1983/ High Accuracy Reference Network (NAD83/HARN). Procedures used to establish horizontal photogrammetric ground control using GPS measurements shall meet or exceed Second Order Horizontal Control as set forth by the FGCC, Geometric Geodetic Accuracy Standards and Specifications for using GPS Relative Positioning Techniques, Version 5.0, May 1988. The vertical control shall reference the North American Vertical Datum of 1988 (NAVD88) using Geoid03 to convert ellipsoidal heights to orthometric heights. Procedures used to establish vertical control shall meet or exceed Third Order Vertical Control Accuracy Standards and Specifications. Procedures for GPS-Derived elevation differences shall meet or exceed Guidelines for Establishing GPS-Derived Ellipsoid Heights (Standards: 2 centimeters and 5 centimeters), NGS-58, November 1997, and/or

Guidelines for Establishing GPS-Derived Orthometric Heights (Standards: 2 centimeters and 5 centimeters), NGS-59, October 2005.

All mapping shall be coordinated in planning procedures and methodology used for all control surveys. Mapping shall meet or exceed FEMA Flood Hazard Mapping Program, Guidelines and Specifications for Flood Hazard Mapping Partners, Appendix A, Section A.5 Ground Control, and Section A.6 Ground Surveys.

5 Deliverables

5.1 Mass Points

- Mass point data shall be delivered in LAS files compatible with the LAS Specification 1.1 format and must meet the requirements identified within this specification including header blocks, variable length records, and point data. Required items not specifically noted as required in the LAS 1.1 Specification are defined in the following sections.

- Data collectors shall make their best effort to avoid holidays in the mass point data as a result of missing mission coverage or system malfunction. Reference Section 5.1.1.1 below for possible methods to deal with holidays.

- The classification code for these files will follow the LAS 1.1 format and will include the following:

    - Class 1 = Unclassified
    - Class 7 = Noise
    - Class 11 = Bare Seafloor
    - Class 12 = Overlap

Class 12 will be used for those LiDAR points, in overlap areas only, deliberately deleted because of their reduced accuracy due to their off-nadir position. Class 1 will be used for all other features that do not fit into the Classes 7, 11, or 12 including vegetation, boats, etc.

- Data collectors will deliver a complete LiDAR cloud where the bare seafloor classification (Class 11) is free of artifacts not representing the bare seafloor. Such artifacts shall be classified as noise (Class 7).

- Public header information must be contained as specified within the LAS 1.1 file specification. In addition to the LAS 1.1 required fields, the following items are required to be populated:

Project ID –GUID data 1: project identifier
File Creation Day of Year: 1
File Creation Year: year created

The project identifier will be populated as follows:

Contractor_TaskOrder_[delivery block name or number]

Ex: ACME_A_5

- The fields *File Creation Day of Year* and *File Creation Year* are the file creation date. This date will represent the day the final LAS file is generated for submittal to the funding agency.

- Projection information for the point data must be specified in the Variable Length Records using the GeoTIFF specification as the model for the LAS 1.1 file specification.

- The Point Data Record Format shall follow the Point Data Record Format 1 as defined in the LAS 1.1 Specification. In addition to the required items, the Intensity shall be populated.

5.1.1.1 Holidays in the Mass Points

There shall be no holidays (data gaps) in the data unless absolutely unavoidable. Interpolation across or smoothing over holidays is unacceptable and may result in rejection of the data by the funding agency. Data collectors shall submit a report describing the circumstances associated with why data holidays were unavoidable. Three examples are listed below to use in deciding how to handle holidays. One of these should be agreed to before data capture begins.

- Example 1 – Fixed Price with Requirement to Re-Fly

  The entire area within the survey limits shall be flown to achieve a minimum of 100% coverage. The maximum depth of LiDAR penetration depends upon water clarity (affected by turbidity, suspended sediments, breaking waves). The maximum depth of detection is two to three times Secchi Depth. Therefore, data collection shall be conducted when the weather and water clarity are such that there is a reasonable assurance of success in the data collection at the survey site and flight plans shall be scheduled to achieve maximum coverage for the inter-tidal zones. Areas where no depths are collected due to poor water clarity shall be re-flown when conditions are better suited for Airborne Hydrographic LiDAR data collection in that specific area. Data collectors shall wait for the second flight until the water quality problems disperse even though this can sometimes take several days or weeks. After the first re-flight, if a gap in coverage still exists, the data collector and funding agency shall meet to evaluate the reason for no depths at that location. If necessary and if deemed beneficial by both parties, a second re-flight will be attempted. However, no more than two re-flights will be done at the data collector's costs.

- Example 2 – Day Rate

  Funding agencies acknowledge and accept that Airborne Hydrographic LiDAR technology can be affected by weather conditions outside of the data collector's control. The following conditions could negatively impact the collection of Airborne Hydrographic LiDAR:

  - Rain
  - Fog
  - Clouds below 400 meters altitude
  - Excessive wind
  - Excessive heat

  Funding agencies acknowledge and accept that Airborne Hydrographic LiDAR technology can be affected by other environmental and water clarity conditions, which are outside of the data collector's control. The following conditions could negatively impact the collection of Airborne Hydrographic LiDAR:

  - High turbidity
  - High currents
  - Excessive phytoplankton in the water column
  - Dense vegetation on the seabed or in the water column

  If one or more of the above conditions prevent the data collector from acquiring Airborne Hydrographic LiDAR data on a given day, then a pre-negotiated "Stand-By" rate shall apply on that day.

  Funding agencies acknowledge and accept that due to the weather, water clarity, and environmental factors mentioned above, it may be impossible for the data collector to guarantee full coverage. Data collectors will address and act in real-time to any environmental factors, such as rain, fog, wind, storms, high currents, sediment influx, or phytoplankton blooms to minimize this impact on the final data product. If a problem with equipment, aircraft, or personnel prevents the data collector from acquiring Airborne Hydrographic LiDAR data on a given day, then no charges to the funding agency shall apply on that day. If a permitting, security, civil aviation, air traffic control, or similar problem outside of the data collector's control prevents acquiring Airborne Hydrographic LiDAR data on a given day, then a pre-negotiated "Stand-By" shall apply on that day, assuming that all other obligations and requirements have been met in this regard.

  The area of interest shall be flown to achieve a minimum of 100% coverage. The maximum depth of LiDAR penetration depends upon water clarity (affected by turbidity, suspended sediments, breaking waves). The maximum depth of detection is two to three times Secchi Depth. Therefore, as mentioned above, data collection shall be conducted when the weather and water clarity are such that there is a reasonable assurance of success in the data collection at the survey site and flight plans shall be scheduled to achieve maximum coverage. Areas where no depths are collected due to poor water clarity can be re-flown, if requested by the funding agency, when conditions are better suited for Airborne Hydrographic LiDAR data collection in that specific area. A pre-negotiated "Survey Operations" rate shall apply on those days, when re-flights have been requested.

- Example 3 – Fixed Price with No Requirement to Re-Fly

  Maximum depth of the LiDAR penetration depends upon water clarity; the expected maximum depth of detection is three times Secchi depth. Therefore, data collection shall be flown on a day when the weather and water quality are present to reasonably ensure the success of data collection at the survey site.

5.2 LiDAR Tiling Scheme

All LiDAR point data must be delivered within the 5000-ft-by-5000-ft tiling scheme defined in the *ProjectName_Bathymetric_LiDAR_Project_Area* feature class. Tiles shall be contiguous and non-overlapping and will be suitable for creating seamless topographic data mosaics that include no "no data" areas. Tiles shall be named as follows:

LIDYYYY_*cellnum*.LAS

where LID stands for LiDAR
YYYY is the year
cellnum is appropriate CELLNUM values found in the standard tiling feature class.

ex: LID2006_00279.LAS

A project tile footprint feature class as defined in Attachment 4 shall be delivered following the naming scheme *ProjectName_Bathymetric_LiDAR_Project_Area*. The footprint feature class must have one text field named CELLNUM (as described above) that identifies the tile number as defined by Attachment 4.

5.3 Metadata

Metadata compliant with the Federal Geographic Data Committee's (FGDC) Content Standard for Spatial Metadata in and ArcCatalog compatible XML format will be delivered. Metadata should be in accordance with recommendation of the National Digital Elevation Program Guidelines for Digital Elevation Data, Version 1. The following minimum guidelines must be adhered to in the metadata:

- There should be one set of metadata per feature class and one set of metadata for each group of LiDAR LAS files corresponding to a homogenous delivery block.
- Metadata must be delivered in a format compatible with ArcGIS 9.x.
- The metadata recommendations defined in Guidelines for Digital Elevation Data, Version 1.0 (http://www.ndep.gov/NDEP_Elevation_Guidelines_Ver1_10May2004.pdf) can serve as a model for the metadata. Metadata may be expanded upon as appropriate.
- Copies of all survey reports including the Minimum Technical Standards (MTS report) must be delivered in PDF format and will be used as attachments to the FGDC metadata.

Metadata will apply to the project as a whole and not to each individual data tile.

- There should be one set of metadata per feature class and one set of metadata for each group of LiDAR LAS files corresponding to a homogenous delivery block.
- Metadata must be delivered in a format compatible with ArcGIS 9.x.
- The metadata recommendations defined in Guidelines for Digital Elevation Data, Version 1.0 can serve as a model for the metadata. Data collectors should expand upon these metadata as appropriate based on their professional expertise.
- Copies of all survey reports must be delivered in PDF format. These will be used as attachments to the FGDC metadata.

5.4 Media

All LiDAR data will be delivered on portable USB or Firewire drives (250 GB minimum) that are labeled with the project name, including data collector and funding agency. Survey reports and metadata will be delivered in printed format and as PDF files on CD-ROM.

5.5 Accuracy Report and Data

All validation data as well as an accuracy report that includes a statistical summary of the data quality shall be submitted to the funding agency. The report shall present the $RMSE_{X,Y}$ and $RMSE_{Z}$, a table summarizing the overall statistics of both the $RMSE_{X,Y}$ and $RMSE_{Z}$ consisting of: number of points, mean, median, mode, skewness, standard deviation, minimum, and maximum representative of each RMSE calculation, as well as a table and separate histogram that illustrate the derived delta between each validation checkpoint and that of the LiDAR mass point cloud.

Data collectors will deliver the x,y,z (latitude, longitude, elevation) data from the control and validation points used for quality control and quality assurance. The control points shall be delivered in ASCII format on the same media used for the elevation data delivery. The control points and validation data shall be delivered with sufficient detail regarding collection to allow tying into the same survey network of control points for an independent survey.

Bathymetric LiDAR Deliverable Summary

Copies	Description	Resolution (Meters)	Datum	Format	Notes
	Bathymetric LiDAR				
1	LiDAR Mass Points	5	NAD83/HARN	LAS	Vertical NAVD88
1	X, Y, Z Control Points			ASCII	
2	Flight Reports			Hardcopy	
1	Flight Reports			PDF	
2	Calibration Reports			Hardcopy	
1	Calibration Reports			PDF	
2	Survey Report			Hardcopy	
1	Survey Report			PDF	
3	LiDAR Processing Report			Hardcopy	
1	LiDAR Processing Report			PDF	
3	Accuracy Report			Hardcopy	
1	Accuracy Report			PDF	
1	Metadata file per feature class			ArcGIS XML	
1	Project tile footprint feature class		NAD83/HARN	ArcGIS File Geodatabase	See Attachment 4
2	Airborne GPS / IMU Data and Reports			Hardcopy plus associated digital data	
1	Airborne GPS / IMU Data and Reports			PDF	
	Bathymetric LiDAR Raw Data including the entire waveform				
	All GPS data including checkpoints, survey forms, RINEX files, and ephemeris files				
	Tide Coordination Table				
	Sensor Maintenance History				
	Optional Bathymetric LiDAR Deliverables				
	Seafloor pseudo-reflectance intensity			GeoTIFF	
	Seafloor reflectance of flight line mosaic				
	Digital Camera Imagery			GeoTIFF	
	Digital Surface Model				

Attachment 1

ORTHOPHOTO GEODATABASE DESIGN

Simple feature class
CUTLINE

Geometry Polygon
Contains M values No
Contains Z values Yes

Field name	Data type	Allow nulls	Default value	Domain	Prec-ision	Scale	Length
OBJECTID	Object ID						
SHAPE	Geometry	Yes					
DATESTAMP_DT	Date	Yes			0	0	8
DESCRIPTION	String	Yes					50
FLIGHTDATE	Date	Yes			0	0	8
SHAPE_Length	Double	Yes			0	0	
SHAPE_Area	Double	Yes			0	0	

Simple feature class
ORTHOCHCKPTS

Geometry Point
Contains M values No
Contains Z values Yes

Field name	Data type	Allow nulls	Default value	Domain	Prec-ision	Scale	Length
OBJECTID	Object ID						
SHAPE	Geometry	Yes					
DATESTAMP_DT	Date	Yes			0	0	8
POINTID	String	Yes					12
DESCRIPTION	String	Yes					250
X_COORD	Double	Yes			0	0	
Y_COORD	Double	Yes			0	0	
Z_COORD	Double	Yes			0	0	

Simple feature class
FOOTPRINT

Geometry Polygon
Contains M values No
Contains Z values No

Field name	Data type	Allow nulls	Default value	Domain	Prec-ision	Scale	Length
OBJECTID	Object ID						
SHAPE	Geometry	Yes					
SHAPE_Length	Double	Yes			0	0	
SHAPE_Area	Double	Yes			0	0	
CELLNUM	String	Yes					8

Attachment 2

SURVEYING AND MAPPING REPORTING GUIDELINES FOR PROFESSIONAL PHOTOGRAMMETRIC MAPPING SERVICES:

THE FOLLOWING OUTLINE PRESENTS GUIDANCE AND REQUIREMENTS FOR PROFESSIONAL SURVEYING AND MAPPING IN THE PROCESS OF PHOTOGRAMMETRIC MAPPING SERVICES FOR THE STATE.

- **PHOTOGRAMMETRIC MAPPING: GEODETIC (HORIZONTAL AND VERTICAL) GROUND CONTROL SURVEYS**
  - THE PROFESSIONAL SURVEYOR AND MAPPER (PSM) SHALL PREPARE A CERTIFIED REPORT OF SURVEY ACCORDING TO FLORIDA ADMINISTRATIVE CODE, CHAPTER 61G17-6, MINIMUM TECHNICAL STANDARDS. THE REPORT SHALL INCLUDE THE FOLLOWING ITEMS:
    - STATE PROJECT TITLE AND REFERENCE NUMBER
    - NAME AND ADDRESS OF CORPORATION (CERTIFICATE OF AUTHORIZATION NUMBER)
    - SURVEYOR IN RESPONSIBLE CHARGE (CONTACT INFORMATION)
    - ABBREVIATIONS; DATA SOURCES; ETC.
    - INTRODUCTION, PURPOSE AND OBJECTIVE
    - DESCRIPTION AND SCOPE OF WORK
    - DESCRIPTION OF EQUIPMENT, SOFTWARE, ETC.
    - DESCRIPTION OF THE ACCURACY STANDARDS AND SPECIFICATIONS, PROCEDURES, AND METHODOLOGY FOR ESTABLISHING GROUND CONTROL (INCLUDING THE QUALITY CONTROL (QC) CHECK POINTS):
      - FGCC, GEOMETRIC GEODETIC ACCURACY STANDARDS AND SPECIFICATIONS FOR USING GPS RELATIVE POSITIONING TECHNIQUES, VERSION 5.0, AUGUST 1989
      - NGS-58, GUIDELINES FOR ESTABLISHING GPS-DERIVED ELLIPSOID HEIGHTS (2CM AND 5CM)
      - NGS-59, GUIDELINES FOR ESTABLISHING GPS-DERIVED ORTHOMETRIC HEIGHTS (2CM AND 5CM)
      - FGCC STANDARDS AND SPECIFICATIONS FOR GEODETIC CONTROL NETWORKS, 1984
      - FEMA FLOOD HAZARD MAPPING PROGRAM, GUIDELINES AND SPECIFICATIONS FOR FLOOD HAZARD MAPPING PARTNERS, APPENDIX A
    - DESCRIPTION AND LISTING OF THE GEODETIC CONTROL (EXISTING AND NEWLY ESTABLISHED) DISPLAYING THE HORIZONTAL AND VERTICAL COORDINATES, DATUMS USED, GEOID MODEL AND ERROR ESTIMATES (95% CONFIDENCE LEVEL)
    - ACCURACY REPORTING IN ACCORDANCE WITH FGDC GEOSPATIAL ACCURACY STANDARDS:
      - REPORT THE HORIZONTAL AND VERTICAL (HEIGHTS) ACCURACIES (LOCAL AND NETWOK) ACCORDING TO THE FGDC STANDARDS FOR GEODETIC NETWORKS (FGDC-STD-OO7.2-1998)
      - REPORT THE ACCURACY ANALYSIS FOR THE CHECK POINT DATA IN SPREADSHEET FORMAT ACCORDING TO THE FGDC GEOSPATIAL POSITIONING ACCURACY STANDARDS, PART 3:NATIONAL STANDARD FOR SPATIAL DATA ACCURACY (FGDC-STD-007.3-1998)

- LISTING OF THE FIELD AND OFFICE PERSONNEL
- DATE OF FIELD SURVEY
- DESCRIPTION OF MONUMENTATION RECOVERED AND SET
- PROFESSIONAL SURVEYOR AND MAPPER CERTIFICATION SHALL INCLUDE THE FOLLOWING: "**THIS PHOTOGRAMMETRIC MAPPING GROUND CONTROL SURVEY IS CERTIFIED AS MEETING OR EXCEEDING, IN QUALITY AND PRECISION, THE STANDARDS APPLICABLE FOR THIS WORK AS SET FORTH IN CHAPTER 61G17-6, FLORIDA ADMINISTRATIVE CODE**."
- EXISTING GEODETIC CONTROL RECOVERY/TO-REACH DESCRIPTIONS, SKETCHES, FIELD NOTES, PHOTOGRAPHS, ETC
- NEWLY ESTABLISHED PHOTOGRAMMETRIC CONTROL LOCATION DESCRIPTIONS, SKETCHES, FIELD NOTES, PHOTOGRAPHS, ETC
- COPIES OF GLOBAL POSITIONING SYSTEM (GPS) DATA LOGS AND A LIST OF GPS OCCUPATIONS
- ALL GPS DATA OBSERVED AND PRODUCED DURING THE SURVEY (DIGITAL FORMAT), INCLUDING THE RAW OBSERVATION DATA, PROCESSED BASELINES, LOOPCLOSURES AND LEAST SQUARES ADJUSTMENTS (FREE AND FIXED)
- A MAP OVERLAY WHICH WILL DISPLAY THE FOLLOWING ITEMS:
  - GPS BASELINE NETWORK, INDICATE REPEATED MEASUREMENTS
  - EXISTING HORIZONTAL AND VERTICAL GEODETIC CONTROL
  - NEWLY ESTABLISHED PHOTOGRAMMETRIC CONTROL
  - QC CHECK POINTS
  - BASE MAP FEATURES (STATE BOUNDARIES, COUNTY BOUNDARIES, MAJOR ROADS, MAJOR HYDROGRAPHY/ WATER BODIES, TOWNSHIP/RANGE LINES, CITIES)

- **PHOTOGRAMMETRIC MAPPING: AERIAL TRIANGULATION, DIGITAL ORTHOPHOTOGRAPHY AND LiDAR TOPOGRAPHIC MAPPING REPORT**

  - THE PSM SHALL PREPARE A CERTIFIED REPORT-OF-SURVEY ACCORDING TO FLORIDA ADMINISTRATIVE CODE, CHAPTER 61G17-6, MINIMUM TECHNICAL STANDARDS. THE REPORT SHALL CONTAIN THE FOLLOWING ITEMS:
    - STATE PROJECT TITLE AND REFERENCE NUMBER
    - NAME AND ADDRESS OF CORPORATION (CERTIFICATE OF AUTHORIZATION NUMBER)
    - SURVEYOR IN RESPONSIBLE CHARGE (CONTACT INFORMATION)
    - ABBREVIATIONS, DEFINITIONS; DATA SOURCES; ETC.
    - INTRODUCTION, PURPOSE, OBJECTIVES
    - SCOPE OF WORK
    - DESCRIPTION OF ALL EQUIPMENT, SOFTWARE, ETC.
    - IMAGING SENSOR DESCRIPTION AND CALIBRATION REPORT
    - AIRBORNE GPS REPORT
    - AERIAL TRIANGULATION CONTROL COORDINATES AND AERIAL TRIANGULATION BLOCKS ALONG WITH STATISTICAL SUMMARIES

Attachment 3

TOPOGRAPHIC GEODATABASE DESIGN

Simple feature class
MASSPOINT

Geometry Multipoint
Contains M values No
Contains Z values Yes

Field name	Data type	Allow nulls	Default value	Domain	Prec-ision	Scale	Length
OBJECTID	Object ID						
SHAPE	Geometry	Yes					
DATESTAMP_DT	Date	Yes			0	0	8

Simple feature class
WATERBODY

Geometry Polygon
Contains M values No
Contains Z values Yes

Field name	Data type	Allow nulls	Default value	Domain	Prec-ision	Scale	Length
OBJECTID	Object ID						
SHAPE	Geometry	Yes					
WATERBODY_ELEVATION_MS	Double	Yes			0	0	
DATESTAMP_DT	Date	Yes			0	0	8
SHAPE_Length	Double	Yes			0	0	
SHAPE_Area	Double	Yes			0	0	

Simple feature class
HYDROGRAPHICFEATURE

Geometry Polyline
Contains M values No
Contains Z values Yes

Field name	Data type	Allow nulls	Default value	Domain	Prec-ision	Scale	Length
OBJECTID	Object ID						
SHAPE	Geometry	Yes					
DATESTAMP_DT	Date	Yes			0	0	8
SHAPE_Length	Double	Yes			0	0	

Simple feature class
COASTALSHORELINE

Geometry Polygon
Contains M values No
Contains Z values Yes

Field name	Data type	Allow nulls	Default value	Domain	Prec-ision	Scale	Length
OBJECTID	Object ID						
SHAPE	Geometry	Yes					
DATESTAMP_DT	Date	Yes			0	0	8
SHAPE_Length	Double	Yes			0	0	
SHAPE_Area	Double	Yes			0	0	

Simple feature class
ROADBREAKLINE

Geometry Polyline
Contains M values No
Contains Z values Yes

Field name	Data type	Allow nulls	Default value	Domain	Prec-ision	Scale	Length
OBJECTID	Object ID						
SHAPE	Geometry	Yes					
DATESTAMP_DT	Date	Yes			0	0	8
SHAPE_Length	Double	Yes			0	0	

Simple feature class
SOFTFEATURE

Geometry Polyline
Contains M values No
Contains Z values Yes

Field name	Data type	Allow nulls	Default value	Domain	Prec-ision	Scale	Length
OBJECTID	Object ID						
SHAPE	Geometry	Yes					
DATESTAMP_DT	Date	Yes			0	0	8
SHAPE_Length	Double	Yes			0	0	

Simple feature class
LOWCONFIDENCE

Geometry Polygon
Contains M values No
Contains Z values No

Field name	Data type	Allow nulls	Default value	Domain	Prec-ision	Scale	Length
OBJECTID	Object ID						
SHAPE	Geometry	Yes					
DATESTAMP_DT	Date	Yes			0	0	8
SHAPE_Length	Double	Yes			0	0	
SHAPE_Area	Double	Yes			0	0	

Simple feature class
ISLAND

Geometry Polygon
Contains M values No
Contains Z values Yes

Field name	Data type	Allow nulls	Default value	Domain	Prec-ision	Scale	Length
OBJECTID	Object ID						
SHAPE	Geometry	Yes					
DATESTAMP_DT	Date	Yes			0	0	8
SHAPE_Length	Double	Yes			0	0	
SHAPE_Area	Double	Yes			0	0	

Simple feature class
OVERPASS

Geometry Polyline
Contains M values No
Contains Z values Yes

Field name	Data type	Allow nulls	Default value	Domain	Prec-ision	Scale	Length
OBJECTID	Object ID						
SHAPE	Geometry	Yes					
DATESTAMP_DT	Date	Yes			0	0	8
SHAPE_Length	Double	Yes			0	0	

Simple feature class
CONTOUR_1FT

Geometry Polyline
Contains M values No
Contains Z values No

Field name	Data type	Allow nulls	Default value	Domain	Precision	Scale	Length
OBJECTID	Object ID						
SHAPE	Geometry	Yes					
CONTOUR_ELEVATION_MS	Double	Yes			0	0	
CONTOUR_TYPE_DESC	String	Yes		dCONTOURTYPE			50
DATESTAMP_DT	Date	Yes			0	0	8
SHAPE_Length	Double	Yes			0	0	

Simple feature class
CONTOUR_2FT

Geometry Polyline
Contains M values No
Contains Z values No

Field name	Data type	Allow nulls	Default value	Domain	Precision	Scale	Length
OBJECTID	Object ID						
SHAPE	Geometry	Yes					
CONTOUR_ELEVATION_MS	Double	Yes			0	0	
CONTOUR_TYPE_DESC	String	Yes		dCONTOURTYPE			50
DATESTAMP_DT	Date	Yes			0	0	8
SHAPE_Length	Double	Yes			0	0	

Coded value domain
dCONTOURTYPE

Description
Field type String
Split policy Default value
Merge policy Default value

Code	Description
1	INTERMEDIATE
2	SUPPLEMENTARY
3	DEPRESSION
4	INDEX
5	INTERMEDIATE LOW CONFIDENCE
6	SUPPLEMENTARY LOW CONFIDENCE
7	DEPRESSION LOW CONFIDENCE
8	INDEX LOW CONFIDENCE

Simple feature class
GROUNDCONTROL

Geometry Point
Contains M values No
Contains Z values Yes

Field name	Data type	Allow nulls	Default value	Domain	Precision	Scale	Length
OBJECTID	Object ID						
SHAPE	Geometry	Yes					
DATESTAMP_DT	Date	Yes			0	0	8
POINTID	String	Yes					12
DESCRIPTION	String	Yes					250
X_COORD	Double	Yes			0	0	
Y_COORD	Double	Yes			0	0	
Z_COORD	Double	Yes			0	0	

Simple feature class
VERTACCTESTPTS

Geometry Point
Contains M values No
Contains Z values Yes

Field name	Data type	Allow nulls	Default value	Domain	Prec-ision	Scale	Length
OBJECTID	Object ID						
SHAPE	Geometry	Yes					
DATESTAMP_DT	Date	Yes			0	0	8
POINTID	String	Yes					12
DESCRIPTION	String	Yes					250
X_COORD	Double	Yes			0	0	
Y_COORD	Double	Yes			0	0	
Z_COORD	Double	Yes			0	0	
LANDCOVER	String	Yes		dLANDCOVERTYPE			36

Coded value domain

dLANDCOVERTYPE

Description
Field type String
Split policy Default value
Merge policy Default value

Code	Description
1	BARE-EARTH AND LOW GRASS
2	BRUSH LANDS AND LOW TREES
3	FORESTED AREAS FULLY COVERED BY TREES
4	URBAN AREAS

Simple feature class
FOOTPRINT

Geometry Polygon
Contains M values No
Contains Z values No

Field name	Data type	Allow nulls	Default value	Domain	Prec-ision	Scale	Length
OBJECTID	Object ID						
SHAPE	Geometry	Yes					
SHAPE_Length	Double	Yes			0	0	
SHAPE_Area	Double	Yes			0	0	
CELLNUM	String	Yes					8

Attachment 4

BATHYMETRIC GEODATABASE DESIGN

Simple feature class
FOOTPRINT

Geometry Polygon
Contains M values No
Contains Z values No

Field name	Data type	Allow nulls	Default value	Domain	Prec-ision	Scale	Length
OBJECTID	Object ID						
SHAPE	Geometry	Yes					
SHAPE_Length	Double	Yes			0	0	
SHAPE_Area	Double	Yes			0	0	
CELLNUM	String	Yes					8

Attachment 5

County Deliverables by Florida State Plane Projection Zone

East	North	West
BREVARD	ALACHUA	CHARLOTTE
BROWARD	BAKER	CITRUS
CLAY	BAY	DESOTO
COLLIER	BRADFORD	HARDEE
DUVAL	CALHOUN	HERNANDO
FLAGLER	COLUMBIA	HILLSBOROUGH
GLADES	DIXIE	LEE
HENDRY	ESCAMBIA	LEVY
HIGHLANDS	FRANKLIN	MANATEE
INDIANRIVER	GADSDEN	MARION
LAKE	GILCHRIST	PASCO
MARTIN	GULF	PINELLAS
MIAMI-DADE	HAMILTON	POLK
MONROE	HOLMES	SARASOTA
NASSAU	JACKSON	SUMTER
OKEECHOBEE	JEFFERSON	
ORANGE	LAFAYETTE	
OSCEOLA	LEON	
PALMBEACH	LIBERTY	
PUTNAM	MADISON	
SEMINOLE	OKALOOSA	
STJOHNS	SANTAROSA	
STLUCIE	SUWANNEE	
VOLUSIA	TAYLOR	
	UNION	
	WAKULLA	
	WALTON	
	WASHINGTON	